



# **JWARS Update to the Space User's Group**

Lt Col Greg McIntyre  
2 Aug 2001



# Topics

- **JWARS Status**
- **Space Functionality Summary**
- **Collection Plan**
- **Input Data Population and Manipulation**
- **Output Analysis Tools**
- **Open Issues**



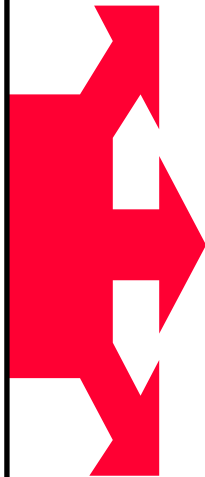
# Mission

**Mission: Develop a state-of-the-art, constructive simulation that will:**

- **Provide a multi-sided and balanced representation of joint theater warfare**
- **Be able to assess current and future operational concepts to include Joint Vision 2010's:**
  - ❖ **Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimension Protection**
- **Use C4 and ISR as the foundation for how entities perceive and interact with one another**

## Users

- **Joint Staff**
- **Services**
- **CINCs**
- **OSD**
- **Joint Task Forces**
- **Other DoD org's**



## Applications

- 1. Force assessment**
- 2. Planning and execution**
  - **Deliberate planning**
  - **Crisis action planning**
- 3. System effectiveness and trade off analysis**
- 4. Concept and doctrine development and assessment**



# Requirements - Warfare Functionality

- Release 1 (Limited IOC)
  - ❖ Include C4, ISR, logistics, and essential functionality in legacy simulations TACWAR and MIDAS.
  - ❖ Be capable of replacing TACWAR for force assessment application.
- Release 2 (Full IOC)
  - ❖ Provide balanced warfare representation, including C4, ISR, logistics.
  - ❖ Be capable of supporting the applications--
    1. Force assessment.
    2. Planning and execution.
  - ❖ Be capable of replacing TACWAR and MIDAS.
- Release 3 (FOC)
  - ❖ Provide balanced warfare representation, including C4, ISR, logistics.
  - ❖ Be capable of supporting the applications--
    1. Force assessment.
    2. Planning and execution.
    3. System effectiveness and trade-off analysis.
    4. Concept and doctrine development and assessment.
  - ❖ Be capable of replacing legacy simulations CEM, Thunder, ITEM, and SUMMITS.



# Release 1 Warfare Functionality Summary

Summary

Limited IOC Functionality	Release 1.3	Limited IOC Functionality	Release 1.3	Limited IOC Functionality	Release 1.3	
<b>C4ISR</b>		<b>Maritime</b>		<b>Air</b>		
Communications	Implemented	Surface to Surface	Implemented	Operational C2	Implemented	
Intelligence						
Sensing						
Reconnaissance						
Perceived Truth						
Indications & Warning						
JTF Command and Control	Functional; work continues	MW (Mine Deployment)	Functional; work continues	Dyanamic ATO Planning	Functional; work continues	
Collection Plan						
<b>Land</b>		Forcible Entry (Amphib)	Functional; work continues	Counter Air (A2A)		Functional; work continues
Maneuver	Implemented	C2				
Direct Fire						
Indirect Fire						
Forcible Entry (Airborne)						
Maneuver Planning		Functional; work continues	ASW (Ship on Sub)	In Development	Attack / Interdiction (A2G)	
Attack Helos						
C2	In Development	ASW (Air on Sub)	In Development	Air Defense (S2A)		
Resupply						
<b>Transportation and Logistics</b>		Combatant Logistics Force	In Development	Air Base Ops	In Development	
Intertheater Lift Scheduling	Implemented	<b>WMD</b>		J TCB Planning		
Intertheater Lift Reschedule		Implemented	Chem Offense	Implemented	Air to Surface (ship)	
Intertheater Lift Movement	Chem Defense (MOPP)		Partially Implemented		SEAD	
Intratheater Lift	Functional; work continues	Unit Effects (Land)		In Development	<b>TBM / TBMD</b>	
Intratheater Lift Reschedule		Unit Effects (Air)	In Development		Threat Missile	Implemented
Intratheater Transportation	Unit Effects (Installations)	In Development		ABL		
Installations	In Development		<b>Data Entry / Retrieval</b>		DSP Cueing	Functional; work continues
Sustainment		Import/Export to Oracle Database	Capable	BMC3		
	Add/Modify Orders	HE Effects				
	Data Modification	Lower Tier (Patriot)				
	Data Dictionary (On-Line View)	Lower Tier (AEGIS))				
	Comparison of Scenario Data	Upper Tier (THAAD)				
	Export Data (Instruments)	Upper Tier (AEGIS)				
				<b>Environmental Effects</b>		
				Terrain	Implemented	
				Networks (Land)		
				Weather	Mostly Implemented	
				Ocenographics		

Notes:- Functional areas displayed are Release 1 (Limited IOC) requirements.

- By Release 1.4, all areas will be Implemented.





# Topics

- **JWARS Status**
- **Space Functionality Summary**
- **Collection Plan**
- **Input Data Population and Manipulation**
- **Output Analysis Tools**
- **Open Issues**



# Space Functionality

- Space Control
  - ❖ Surveillance
  - ❖ Protection
  - ❖ Prevention
  - ❖ Negation
- Space Support
  - ❖ Space Lift
- Force Application
  - ❖ Space Based Laser

- Computer Network Attack/Defense

- Force Enhancement
  - ❖ Warning
  - ❖ Communications
  - ❖ Weather
  - ❖ Navigation/Timing
  - ❖ Intelligence
  - ❖ Surveillance & Reconnaissance





# Force Enhancement - Warning

- Currently provide warning of enemy attack
  - ❖ MOP is Days of Warning (user controlled states of pre-ambiguous, ambiguous, and unambiguous)
- Provide DSP warnings whether as start of war or during the conflict
- Planning to provide “key event” warnings after the war has started
  - ❖ Enemy subs have put to sea
  - ❖ Chemical weapons stores have been issued
  - ❖ Other?
- Every “key event” requires a friendly reaction



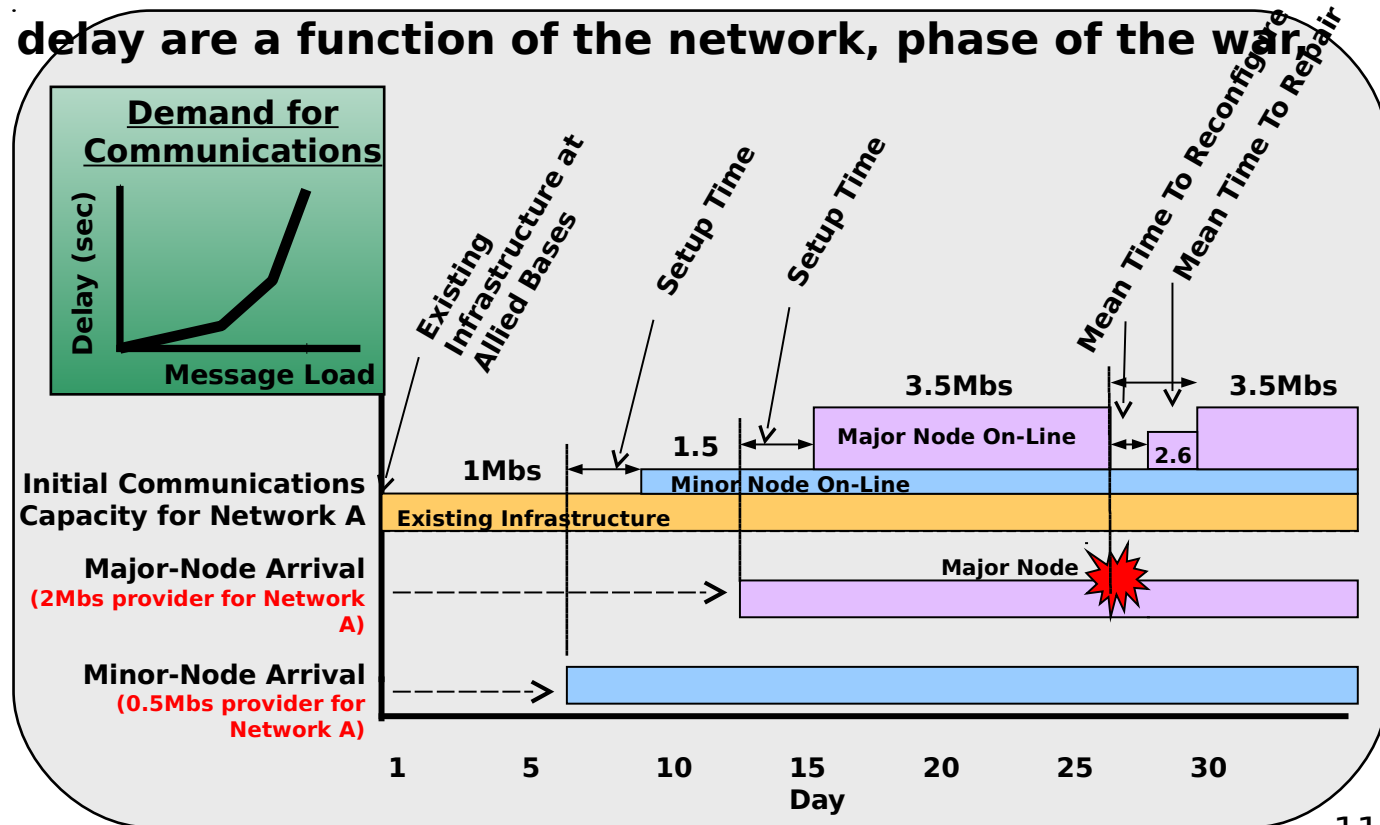
# Force Enhancement - Communication

- New concept in communications better supports play of space assets
  - ❖ Explicit representation of comms providers including satellites
  - ❖ But only those with a direct interface to theater communications
  - ❖ JWARS has no global representation of communications
- Communication representation works for both sides (Blue and Red)
- Could represent commercial assets also



# Communications

- Important messages are simulated explicitly; others are “background” traffic.
- 144 message types sent explicitly, e.g.:
  - *Sensor Reports (multiple types)*
  - *Resupply Requests*
  - *Battle Damage Assessments*
  - *Undersea Warfare Orders*
- Multiple networks with individually defined capabilities.
- Network demand and delay are a function of the network, phase of the war, and time of day.
- Each unit can be on multiple networks.
- Network performance and connection defined in data, which can be modified by





# Force Enhancement - Weather

- JWARS has 18 months of SWA weather 1997-1998
  - ❖ Obtained through DMSO Environmental Scenario Generator
    - » Coherent weather data for air, land, & sea to 1 deg at multiple altitudes
  - ❖ Can start scenario on any date and get the appropriate weather for the entire Theater.
  - ❖ Or can repeat segments of interest, e.g.
    - » Most cloudy
    - » Sandstorms, etc.
- But only a limited number of effects to date
  - ❖ Winds used for take-off criteria and movement of chemical clouds
  - ❖ Cloud cover reduces air attack and ABL effectiveness
  - ❖ Sea state considered for amphibious landing
  - ❖ Temperature used for MOPP degradation criteria



# Force Enhancement - Navigation/GPS

- Large unit navigation is unlikely to be affected
  - ❖ Size of unit is large compared to potential error
- Small unit, aircraft, and ships
  - ❖ Error could mean missing the objective or the target
  - ❖ Alternative systems remain available for navigation
- GPS guided weapons
  - ❖ If GPS loss or errors likely, GPS guided weapons would not be used
  - ❖ Jamming effects part of future threat



# Force Enhancement - Intelligence

- Impacts perception based decisions and actions

**I&W**

## Blue JTF Phase 1 (Deter/Deploy)

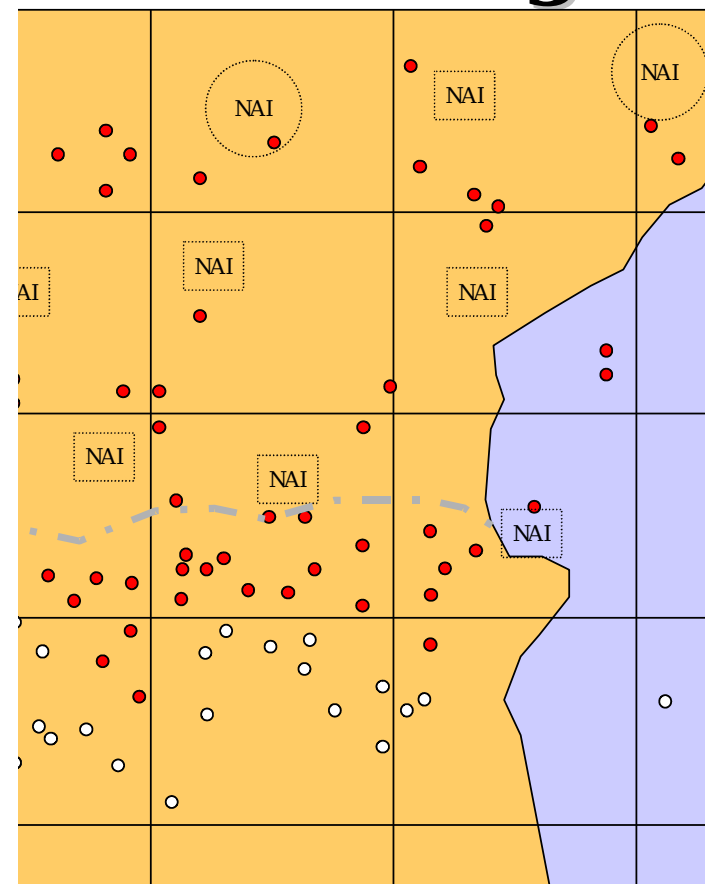
STATE	STATE NAME	Major Enemy Movement Perceived	Major Enemy Movement Perceived Below Designated Phase Line	JTF Actions
S1	#PREAMBIGUOUS	False	False	No action Rqd
S2	#AMBIGUOUS	True	False	I-Day Declared
S3	#UNAMBIGUOUS	True	True	W-Day Declared C-Day Declared at W+24 Hrs
S4	#SURPRISED	False	True	I-Day and W-Day Declared C-Day Declared

**Targeting**



**BDA**

**Planning**





# Topics

- **JWARS Status**
- **Space Functionality Summary**
- **Collection Plan**
- **Input Data Population and Manipulation**
- **Output Analysis Tools**
- **Open Issues**



# ISR Collection Resources

## Air



Cobra Ball



F-14 TARPS



Global Hawk



JSTARS



Predator



Rivet Joint

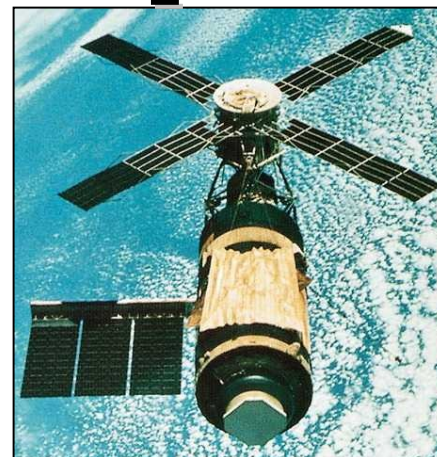


Guardrail



U-2

## Space



## Surface



### ISR Sensor categories represented in JWARS:

- Electro-Optical (EO)
- Infra Red (IR)
- Synthetic Aperture Radar (SAR)
- Moving Target Indicator (MTI)
- Communications Intelligence (COMINT)
- Electronic Intelligence (ELINT)

**NOTE:** In order to represent any possible future, JWARS provides a generic capability to represent any kind of platform and associate with it any kind of sensor with any intelligence discipline. The fact that such a modeling capability exists does not imply that any such system exists, is planned, or is even feasible.





# ISR Resource Availability / Capability

## ➤ Aircraft:

- ❖ Availability is function of OOB and TPFDD (collection plan input)
- ❖ Platform performance in data
- ❖ Sensor performance in data
- ❖ Missions flown through ATO (collection plan output)

## ➤ Satellites (IMINT, SIGINT, & RADAR)

- ❖ Number of passes per planning period (user input, can vary over time)
- ❖ Duration over play box (user set)
- ❖ Coverage area per pass (m<sup>2</sup>) (user set)
- ❖ Sensor performance in data
- ❖ Quality - f(coverage area, classification level)

## ➤ Surface

- ❖ Availability is function of OOB and TPFDD
- ❖ Platform performance in data
- ❖ Sensor performance in data
- ❖ Missions placed through orders (no collection plan input)



# Collection Management Approach

- JWARS scenario input must address two things:
- The base ISR sensor coverage strategy by scenario phase (the user must decide how ISR systems will be distributed across the theater ensure perception sufficiently addresses all supported areas)
- The events (criteria) that cause the base coverage to change (the user establishes rules that, once triggered, cause changes in priority, search area assignment, etc.)
  - ❖ Increases / decreases in the numbers and types of ISR systems
  - ❖ Changes in enemy activity
  - ❖ Changes in the environment
  - ❖ Changes in political boundaries / coalition membership\*
  - ❖ Execution of operations plans (e.g., amphibious assault)

**Key aspects are search orientation & prioritization**



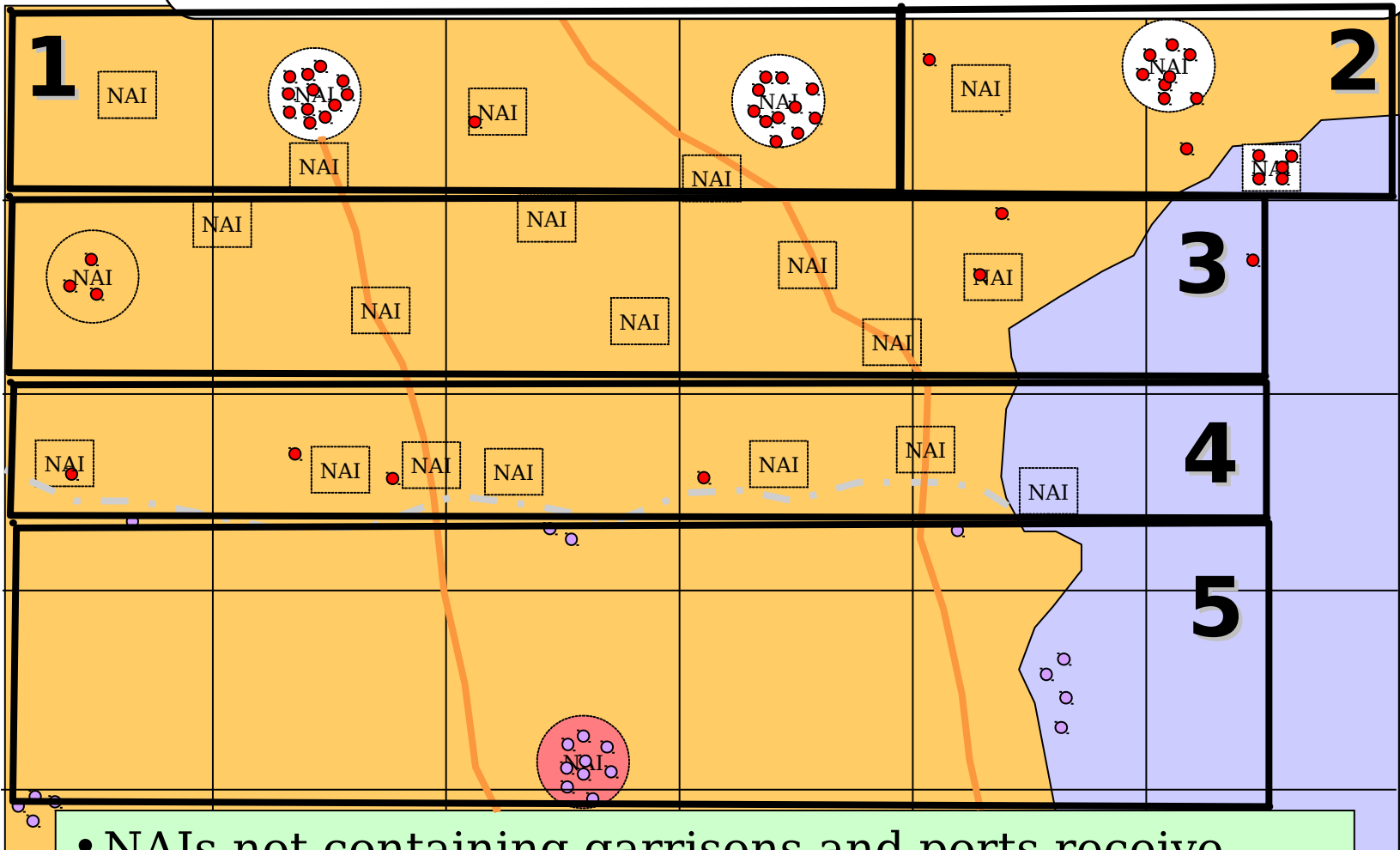
# Collection Plan Extract

Mission Priority	Platform	Sensor	Search Orientation	Area / Unit / Mission / Cueing Source	Search Criteria	Coverage (# of visits) per Day	Platform Priority	Alternate Platform
1	J STARS (E8C)	MTISensor SARSensor	UAI	3rd Corps	N/A	Continuous	1	U2
2	Satellite-IMINT	EOSensor IRSensor	NAI	INTEL1, INTEL2	Garrison	N/A	1	Global Hawk
2	Satellite-IMINT	EOSensor IRSensor	NAI	INTEL2	Mobility	N/A	2	
2	Satellite-IMINT	EOSensor IRSensor	NAI	L63	N/A	N/A	3	
2	Satellite-SIGINT	COMINTSensor ElintSensor	NAI	L53	N/A	N/A	1	
2	Satellite-Radar	MTISensor SARSensor	NAI	L33	N/A	N/A	1	

- Analysis of the Satellite-IMINT Collection Planning
  - ❖ Garrison locations in INTEL1 and INTEL2 are the number one priority (revisit times for Garrisons are considered)
  - ❖ Mobility routes in INTEL2 are the second priority and are only considered if priority one requirements are satisfied
  - ❖ General search of NAI L63 is the third priority and only considered if priorities 1 and 2 are satisfied



# ***Initial Priority Given to NAIs Containing Garrisons and / or Ports***



- NAIs not containing garrisons and ports receive lower priority
- Changes in situation can cause priorities to change



# NAI Categories

Category	Description
Mobility	Routes, Avenues of Approach, Bridges
Installation	Garrisons, Ports, Airfields
Strategic	Power Plants, Factories, Refineries
Logistics	Depots
TBM	TBM Operating Areas
Air	Air Sectors (SEAD, etc.)
Intel	Geographic Breakdown of Theater for Collection Purposes
ASW	Submarine Areas
Country	Physical area belonging to a nation
MTI/SAR	Intelligence Discipline Specific
IMINT	Intelligence Discipline Specific
SIGINT	Intelligence Discipline Specific

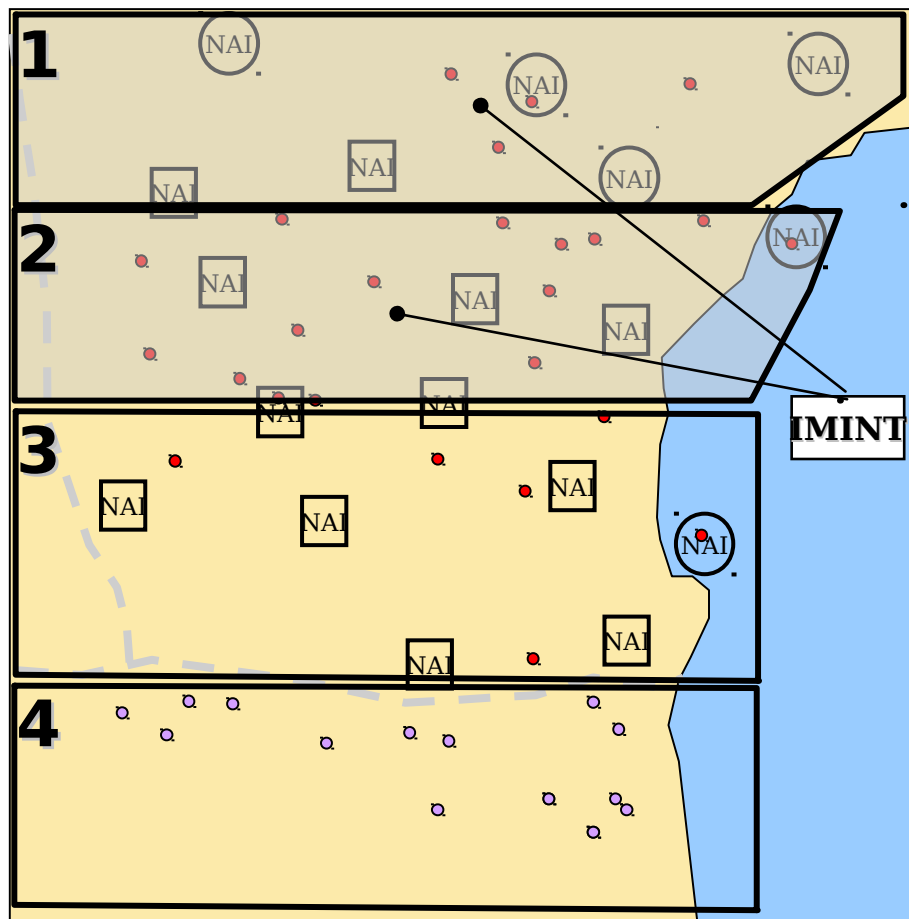
- NAI categorization allows planning based on specific objectives (e.g., a collection requirement to search the NAIs containing installations is easily translated into code)
- NAI categorization eliminates the requirement for NAI naming conventions (e.g., all NAIs beginning with “m” are mobility NAIs)



# Building Satellite-IMINT Collection Requirements

- Satellite-IMINT missions in the Collection Plan are considered and a single list of each area to be collected against is developed
  - ❖ Each area has an associated priority based on the mission and system priorities
  - ❖ Each area has a revisit time (user set)
- For each satellite pass
  - ❖ The Collection List is sorted based on priority and revisit time
  - ❖ Areas are assigned to each pass up to the limit of coverage
- If capacity exceeds requirements, redundant coverage occurs (areas are observed before the required revisit time)

# Search Orientation (1 of 2)



**Example: 4 Regions where an NAI search is conducted in Region 1 and an area search based on JEF locations is conducted in Region 2**

## ➤ NAI

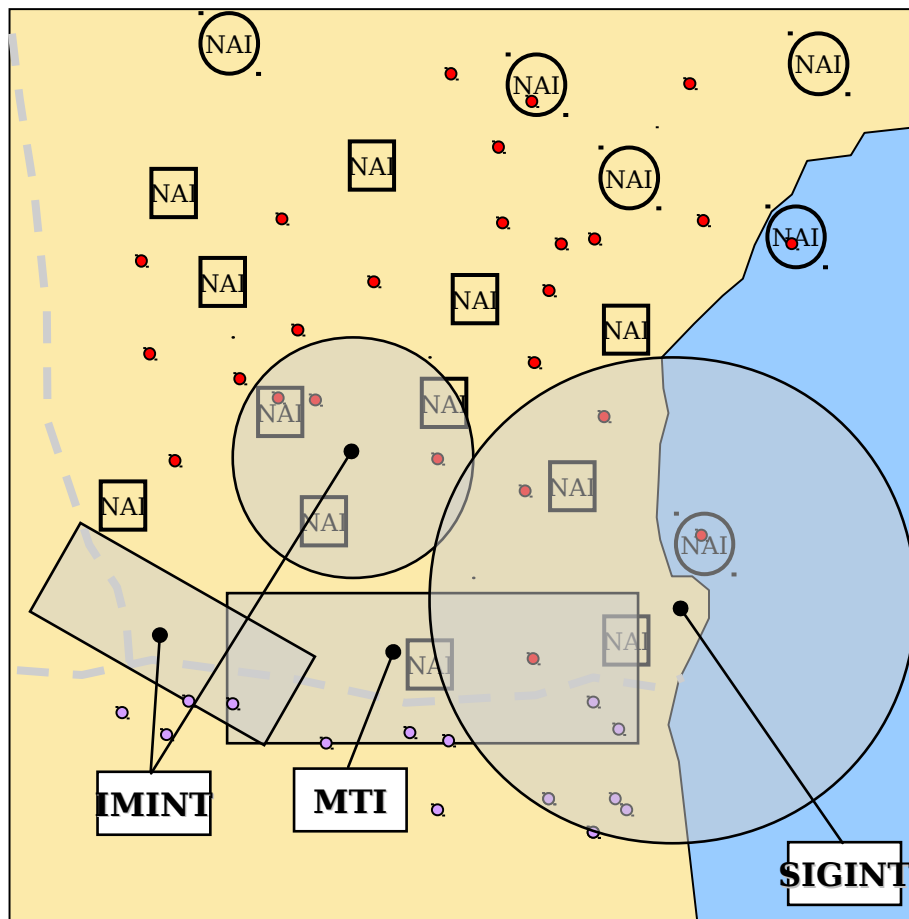
- ❖ Different NAI categories (e.g., mobility, installation, strategic, TBM); categories are prioritized by system based on activity
- ❖ Regionally selected; regions are prioritized
- ❖ NAIs within category are prioritized

## ➤ JEF

- ❖ Derived from perception
- ❖ Can be regionally based
- ❖ Prioritized by organization type



# Search Orientation (1 of 2)



**Example: 4 ISR systems, IMINT & MTI oriented by UAI, IMINT and SIGINT oriented by mission**

- **Unit Area of Interest (UAI)**
  - ❖ (e.g., relative to the location of ground units or maritime units)
- **Mission**
  - ❖ (e.g., in support of the JTCB targeting process, pre or post strike)
- **Dynamic Cued**
  - ❖ (e.g., Predator cued by Guardrail or F14TARPS cued by DSP)





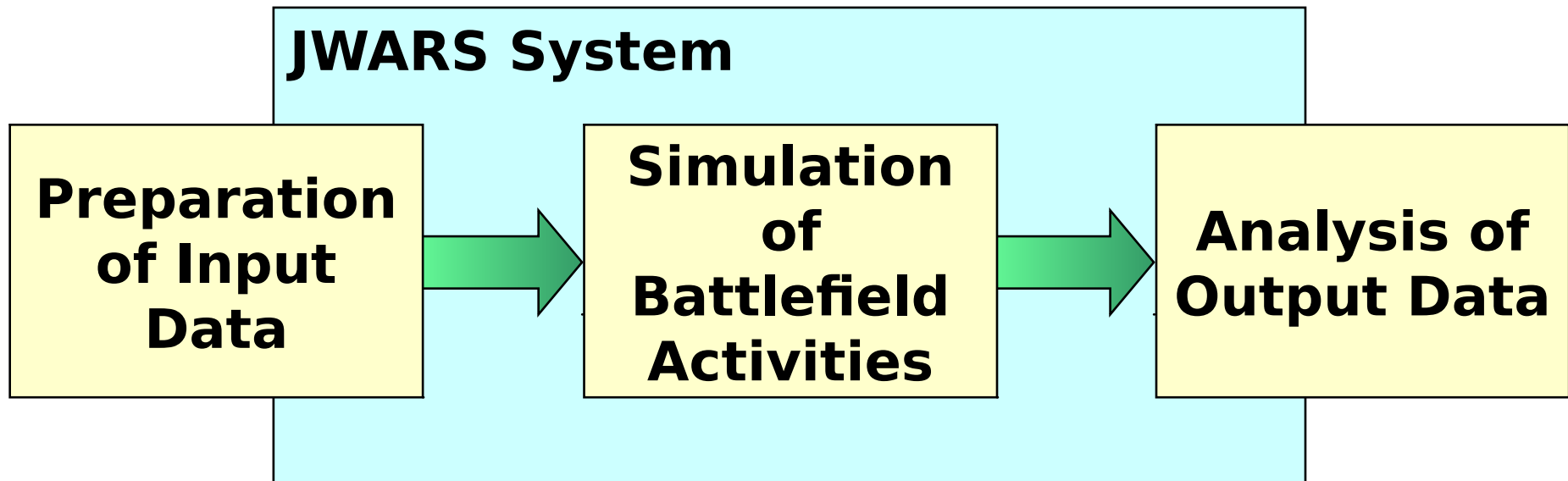
# Topics

- **JWARS Status**
- **Space Functionality Summary**
- **Collection Plan**
- **Input Data Population and Manipulation**
- **Output Analysis Tools**
- **Open Issues**



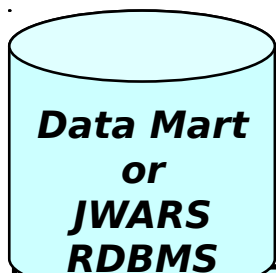
# ***JWARS System***

*(slide 1 of 2)*





## JDS

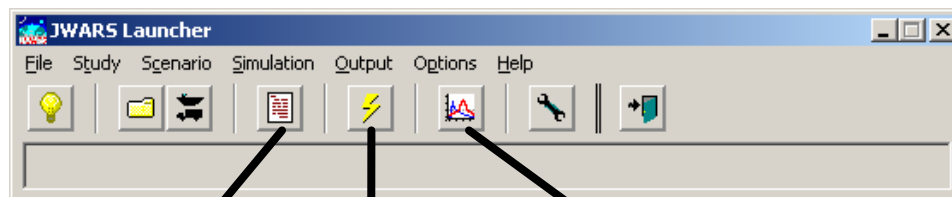


### Views

- Formally define input data requirements and structure.
- Minimize coupling between JDS Data Mart and JWARS objects.
- Permit JDS to independently design and populate Views.
- Permit JWARS to independently design and implement JWARS.
- Can be logical or physical tables.

# JWARS System (slide 2 of 2)

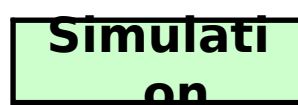
## JWARS



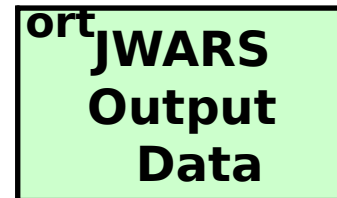
Manipulate



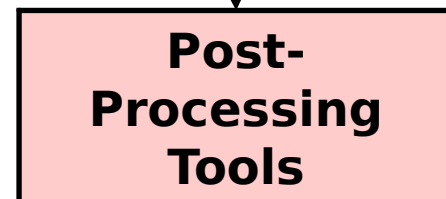
Execute



Retrieve/Report



## Analysis





# Scenario Construction Process

## 0. Identify Playbox Boundaries

### 1. Where - Obtain Environmental Data

- Terrain (CTDB)
  - Movement Infrastructure
- Weather
- IWEDA Rules

### 2. What - Define Forces (Forces, Units, and Equipment, and how they get to theater)

- Top Level: OOB and TPFDD
- Details by functional area
  - Maritime
  - Air
  - Land
  - Trans and Log
  - Sensors
  - Communications
  - WMD

### 3. How - Employ Forces (Develop Operational Plans)

- Top Level
- Details by functional area
  - Maritime
  - Air
  - Land
  - Trans and Log

## Input Data

### Notes

- *Process presupposes:*
  - Study to be performed, or Operations Plan to be evaluated.
  - Scenario context.
- *Contents of Boxes 1, 2, and 3 are described in supporting worksheets.*

## JWARS Input Data

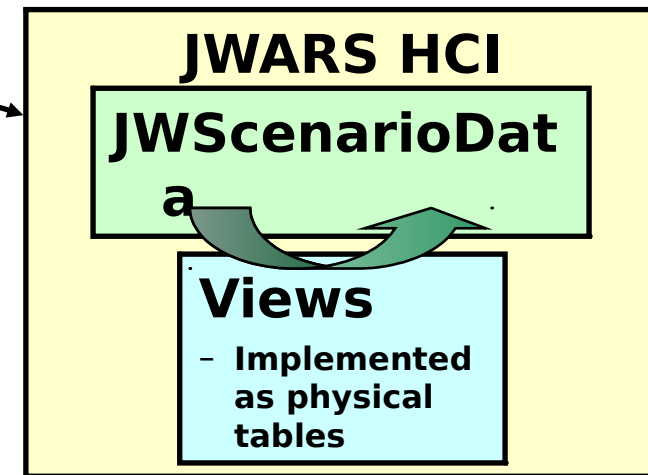
Environmental Data

JWScenarioData  
(stored in BLOBs)



# Accomplishments

- Practically speaking, JWARS input data are stored in an object-oriented database, with added benefit that Oracle BLOBs are used to store data in a memory-efficient manner.
- User can access and manipulate input data--
  1. Through JWARS Scenario Explorer tool and other Graphical User Interfaces (GUIs), to make changes to individual items or a small number of items.
  2. Through Import/Export of tables to make large-scale changes (illustrated at right).
- Manipulation of input data is separate from execution. Both are implemented in Smalltalk.
- The JWARS has developed and will expand upon a family of data manipulation tools, including:
  - Scenario Data Editing
  - Scenario Data Import/Export
  - Scenario Data Composition (by major components)
  - Scenario Data Comparison
  - Scenario Data Configuration Management
  - Scenario Data Transformation





# Approach to Operations

(slide 1 of 2)

## Initial Development of Scenario

### Baseline

#### Guidance

- Playbox
- Forces
- Year
- Equipment surrogation
- ...

Use  
r

Environment  
al Sources

Use  
r

**JWARS**

Environment  
al Data

**JWARS Input  
Data  
("What" data  
only)**

User  
(Movement  
Infrastruct  
ure  
Preprocess  
or)

**JWARS Input  
Data  
(Fully  
Populated)**

User  
(JWARS  
Data  
Consistenc  
y Checks  
\*)

User  
(JWARS  
GUIs)

**"How"  
data**

Back to  
JDS

**JDS**

Data Mart  
or  
JWARS  
RDBMS

\* Data Consistency Checks available at  
Release 1.4

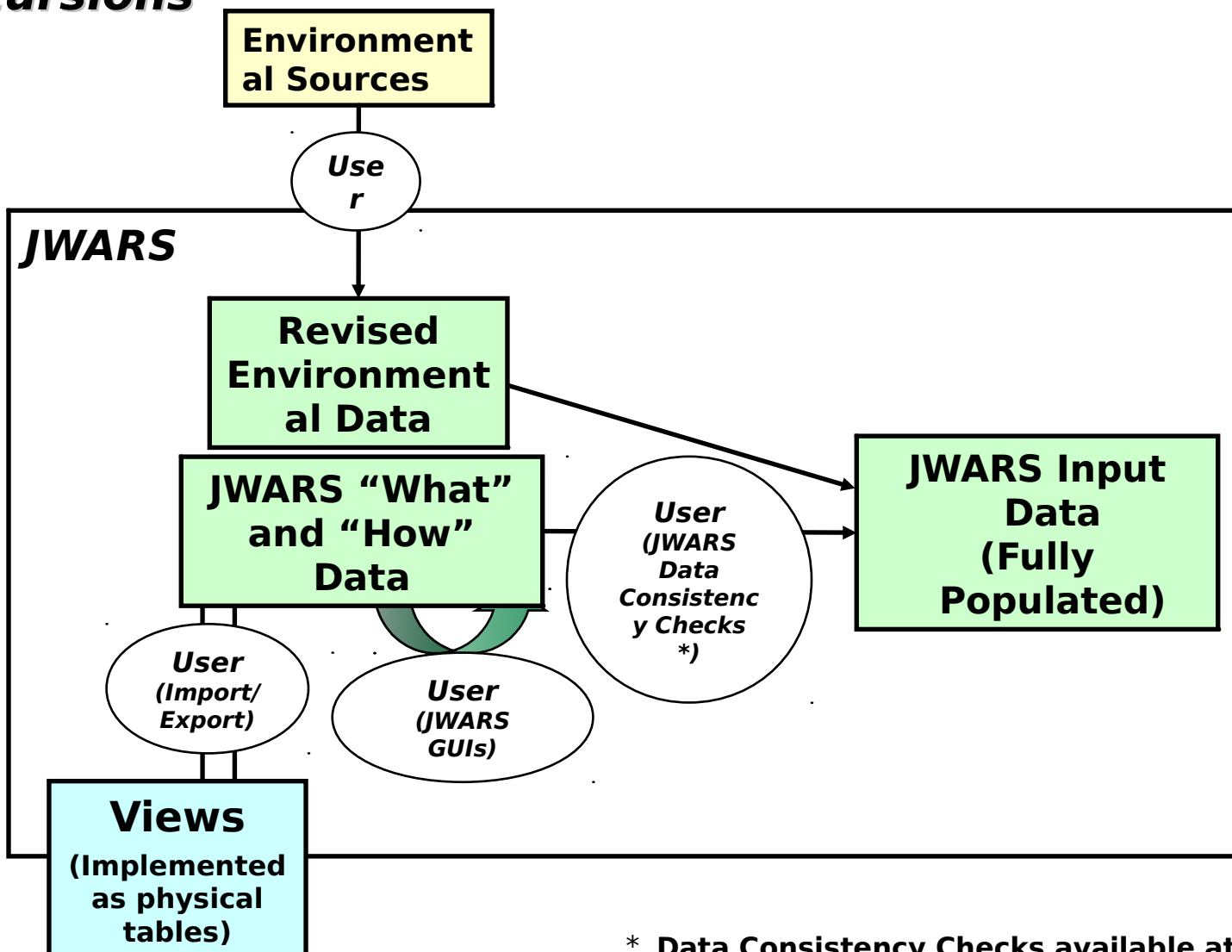


# Approach to Operations

(slide 2 of 2)

Refinement of S  
Excursions

elopment of



\* Data Consistency Checks available at Release 1.4



# ***Summary***

## **This approach**

- **Places internal-to-JWARS storage of input data the center of data manipulation function**
- **Is practical**
  - **Provides necessary data manipulation capabilities**
  - **Places development of “How” data in hands of user**
- **Will be fully implemented at Release 1.4**





# Topics

- **JWARS Status**
- **Space Functionality Summary**
- **Collection Plan**
- **Input Data Population and Manipulation**
- **Output Analysis Tools**
  - ❖ **HCI Quick Plots**
  - ❖ **Grapher2000**
  - ❖ **Multi-dimensional Visualization**
- **Open Issues**

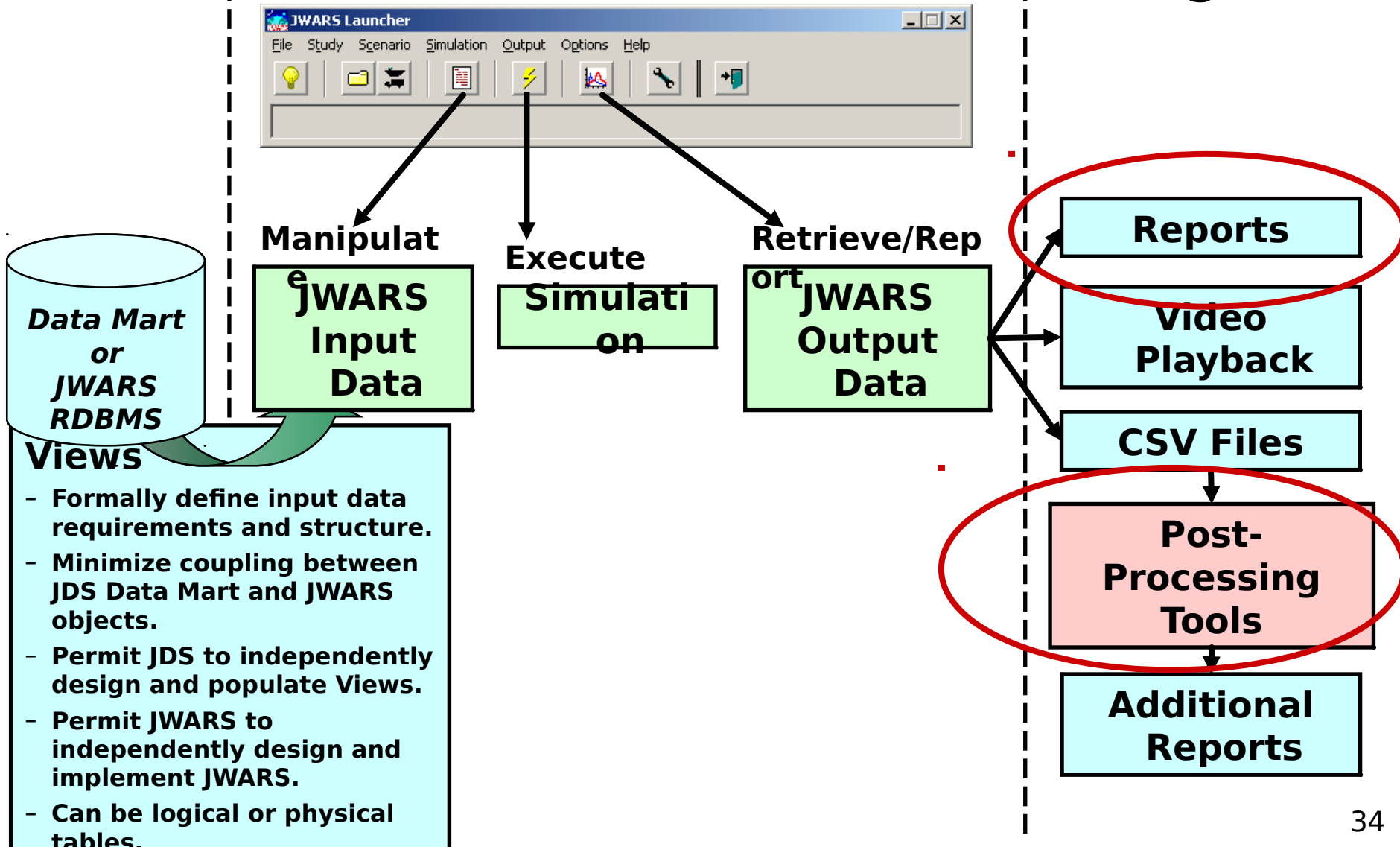


# JWARS System

**JDS**

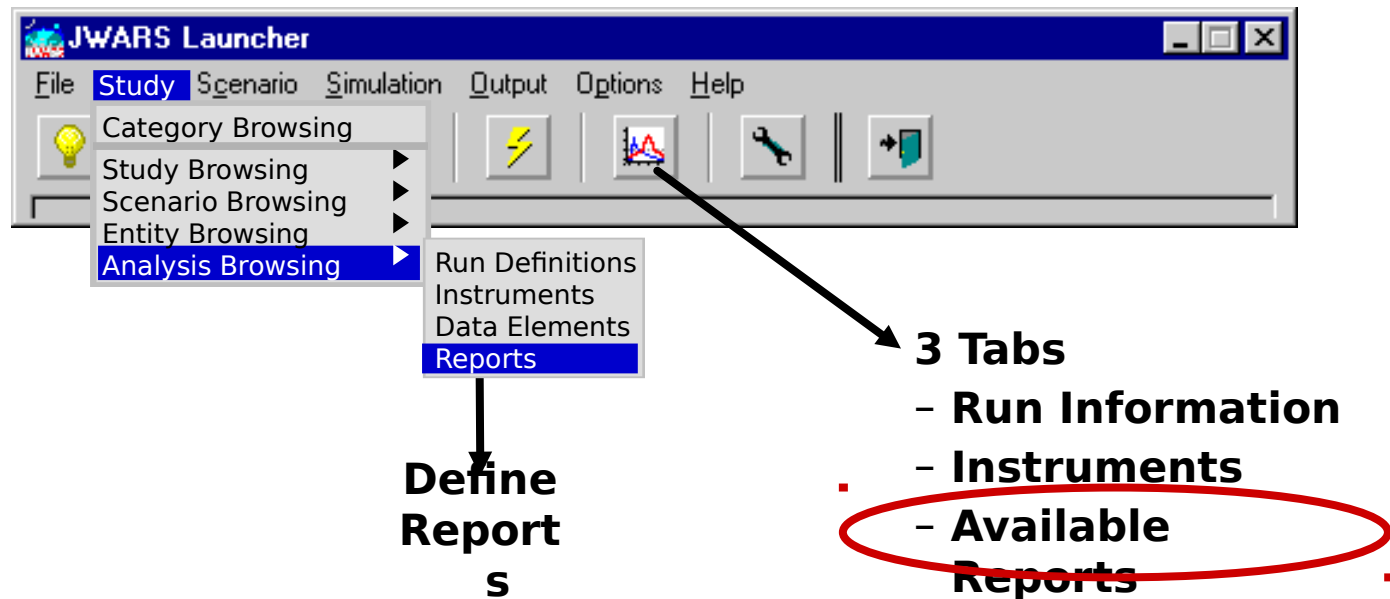
**JWARS**

**Analysis**











# HCI Quick Look Plots



**Charts of a single instrument for a single replication**

Report Browser

File Edit Options Help



UNCLASSIFIED

Group by Owner

AUNGUYTD

JONESJW

KOPELOBG

MCINTYGA

McIntyre -

McIntyre -

McIntyre -

McIntyre -

OSBORNHS

PAINTERD

POUMADML

SOLYRM

STONEGF

WOLCOTCE

OverviewRelationshipsTime StampData DefinitionReport DefinitionSample Report

Report Type: ☒ Graph ☐ Map ☐ Table

Range of Simulation Time Selection

Simulation Time From 0 To 1000 ☐ Select All: 0 - Max

Assign Data Fields (Column Header) To Graph Axes

	Column Header	Graph Axis
1	BSE Count	Y-Axis (Data)
2	Day	X-Axis (Groups)
3	Side	Legend (Series)

Multiple Y-Axis Fields

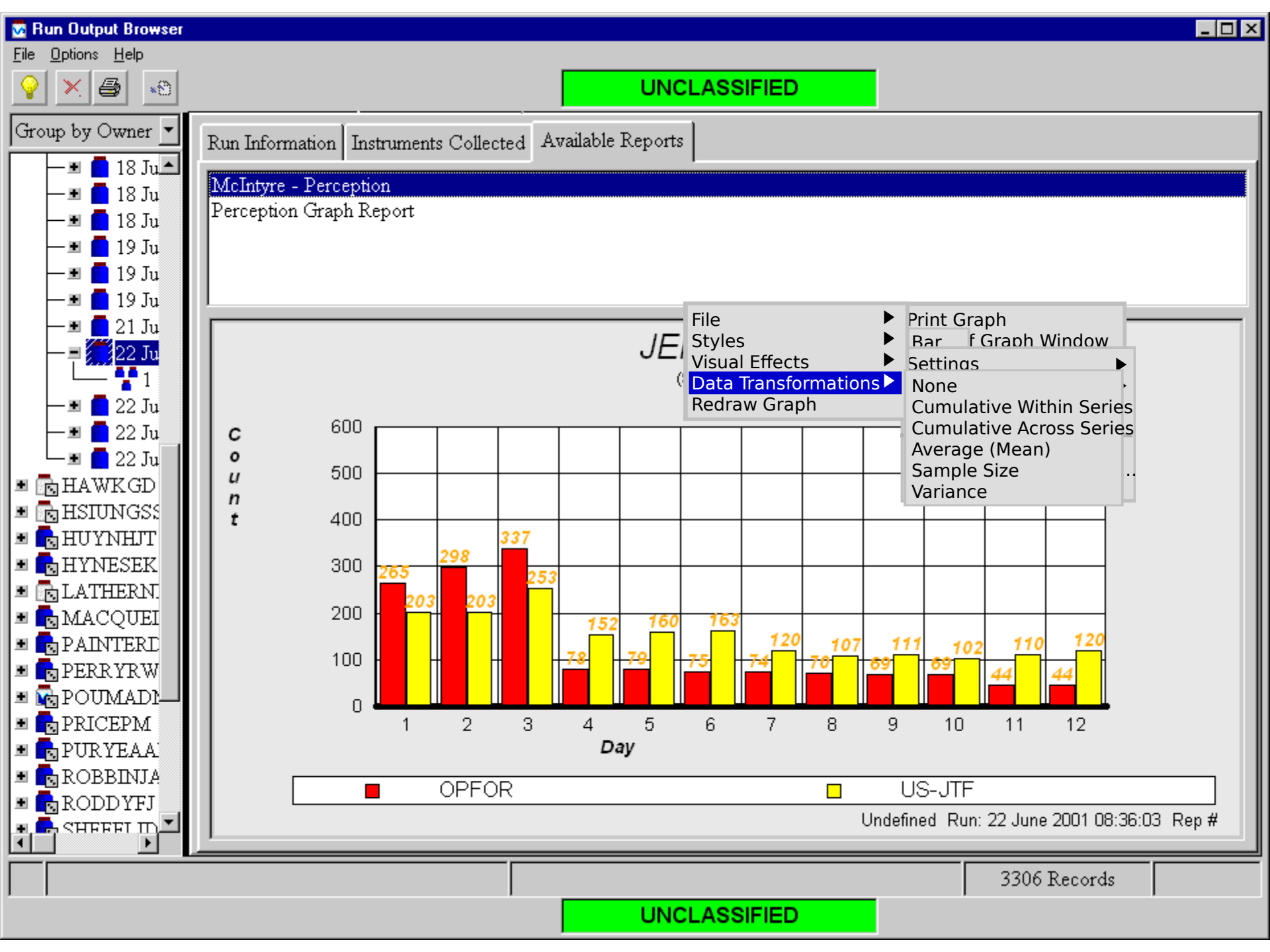
Data Title:

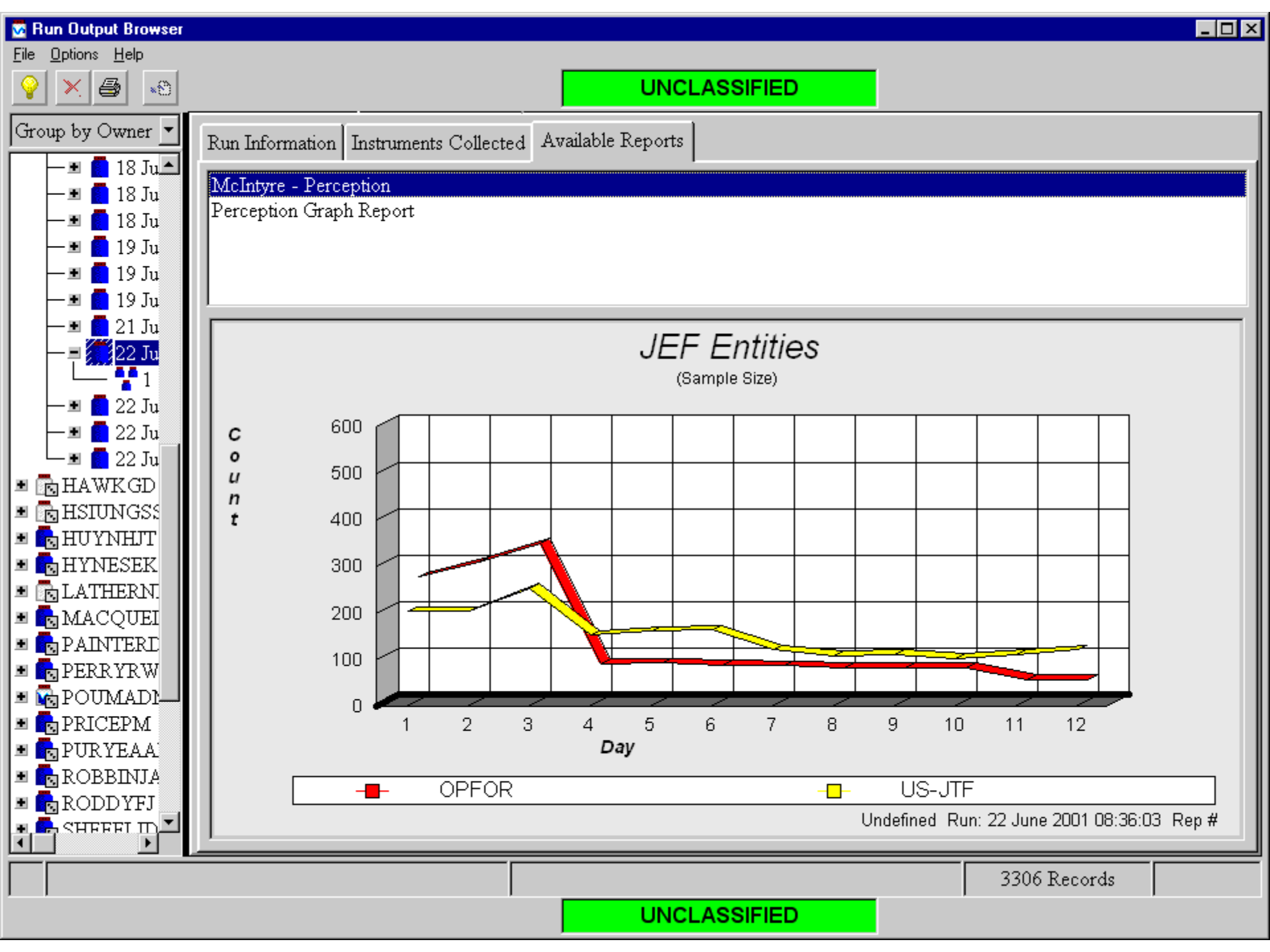
Series Title:

Initial Graph Type: Bar

Advanced Settings

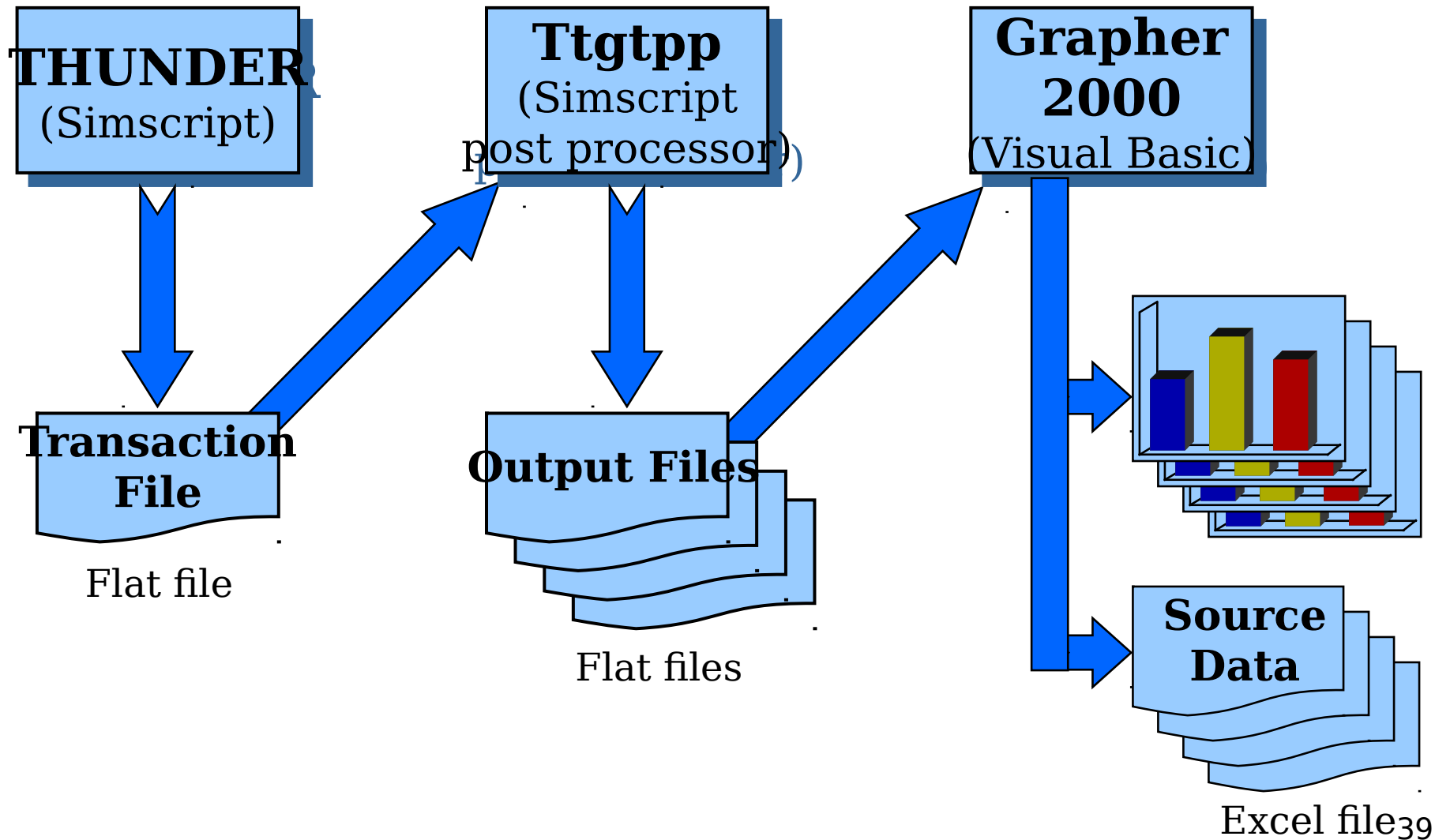
UNCLASSIFIED





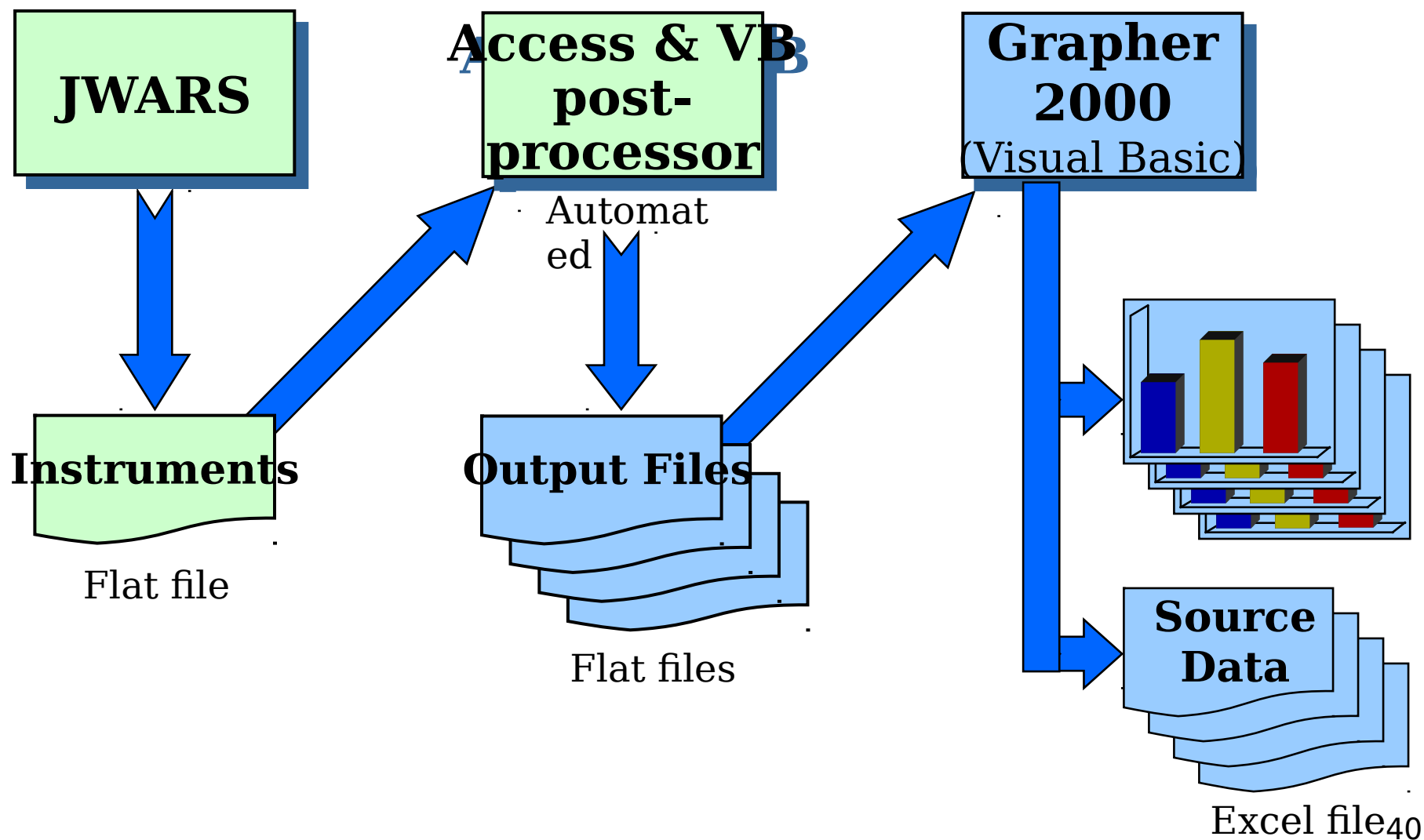


# Grapher 2000 Process





# JWARS Implementation







# Constructing the Output Files

## Input Data



## Type File

Air To Air Adjudication Killer Victim Scoreboard - Kills

Air-to-Ground Killer-Victim Scoreboard

Air-to-Ground Munitions Expended

ATO Execution Air Base Operations

ATO Generation Allocation

ATO Generation Launch Inventory

Surface-to-Air Engagement

Surface-to-Air Killer-Victim Scoreboard

Surface-to-Air Rounds Fired



Basic  
File



Loss  
File



Plan  
File



# Multi-Dimensional Visualization Research Project

- **Purpose**
  - Utilize multi-dimensional visualization for V&V
- **Sponsors**
  - MCCDC and AFSAA
- **Performer**
  - MuSE Technologies
  - Sophisticated visualization software
- **General approach**
  - Apply visualization software to JWARS instrument output data
- **Specific approach for this project:**
  - JWARS Office executed Micro (Gold) scenario
  - JWARS Office provided data from six instruments
    - Initially (Nov 2000) unclassified
    - Later (July 2001) classified
  - MuSE asked to develop four displays



# Background

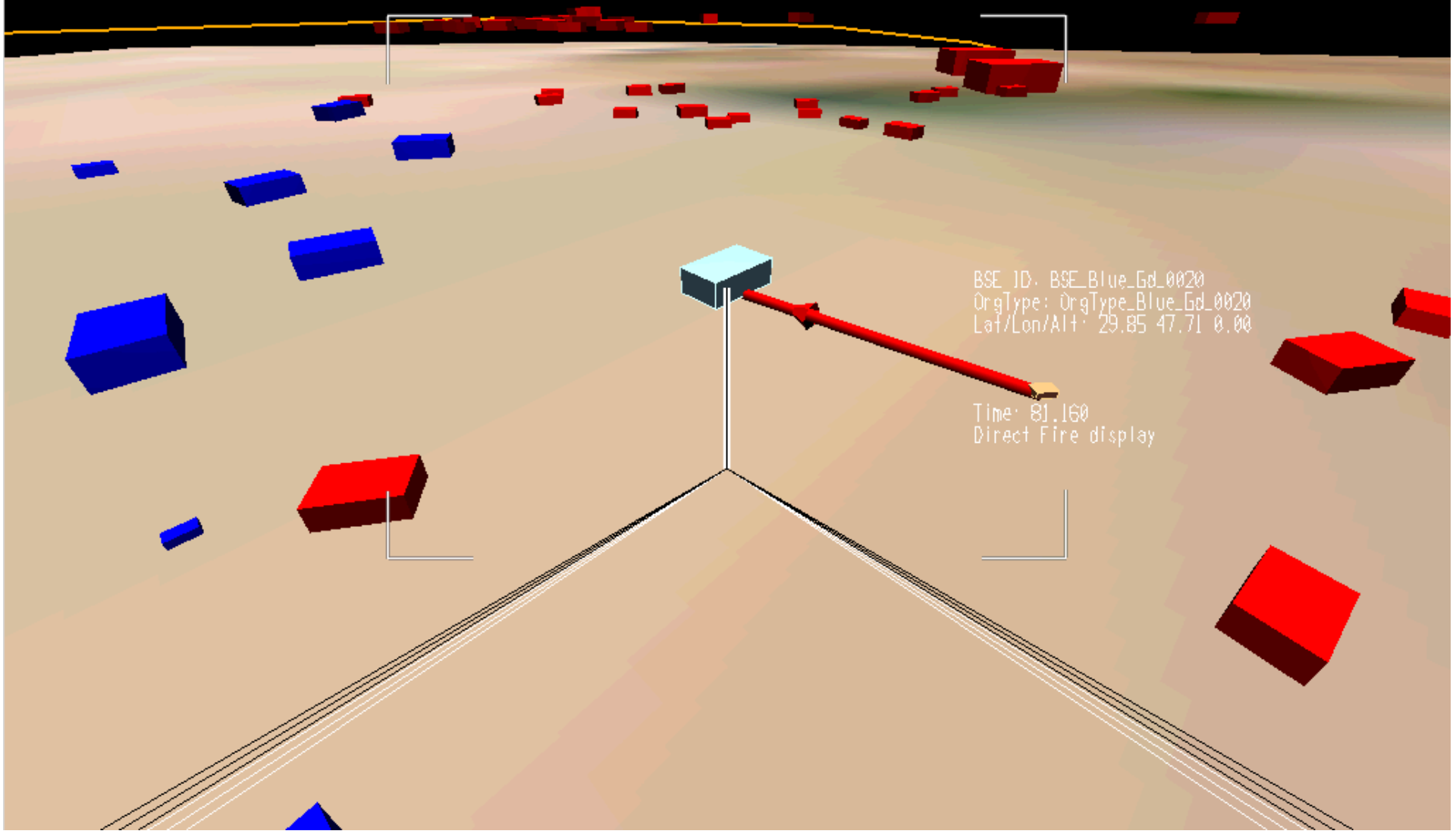
- **Instruments provided**

1. **Map Information - BSE Position Updates**
  2. **Map Information - BSE Removal**
  3. **Airborne ISR Sensor Platforms** *(new for this project)*
  4. **Sensor Report**
  5. **Perception Report**
  6. **Direct Fire Interactions**
- (already used for video playback)*

- **Displays sought**

1. **Unit movement**
2. **Blue ISR sensor movement and sensing**
3. **Blue Situation Map**
4. **Direct Fire Engagements**

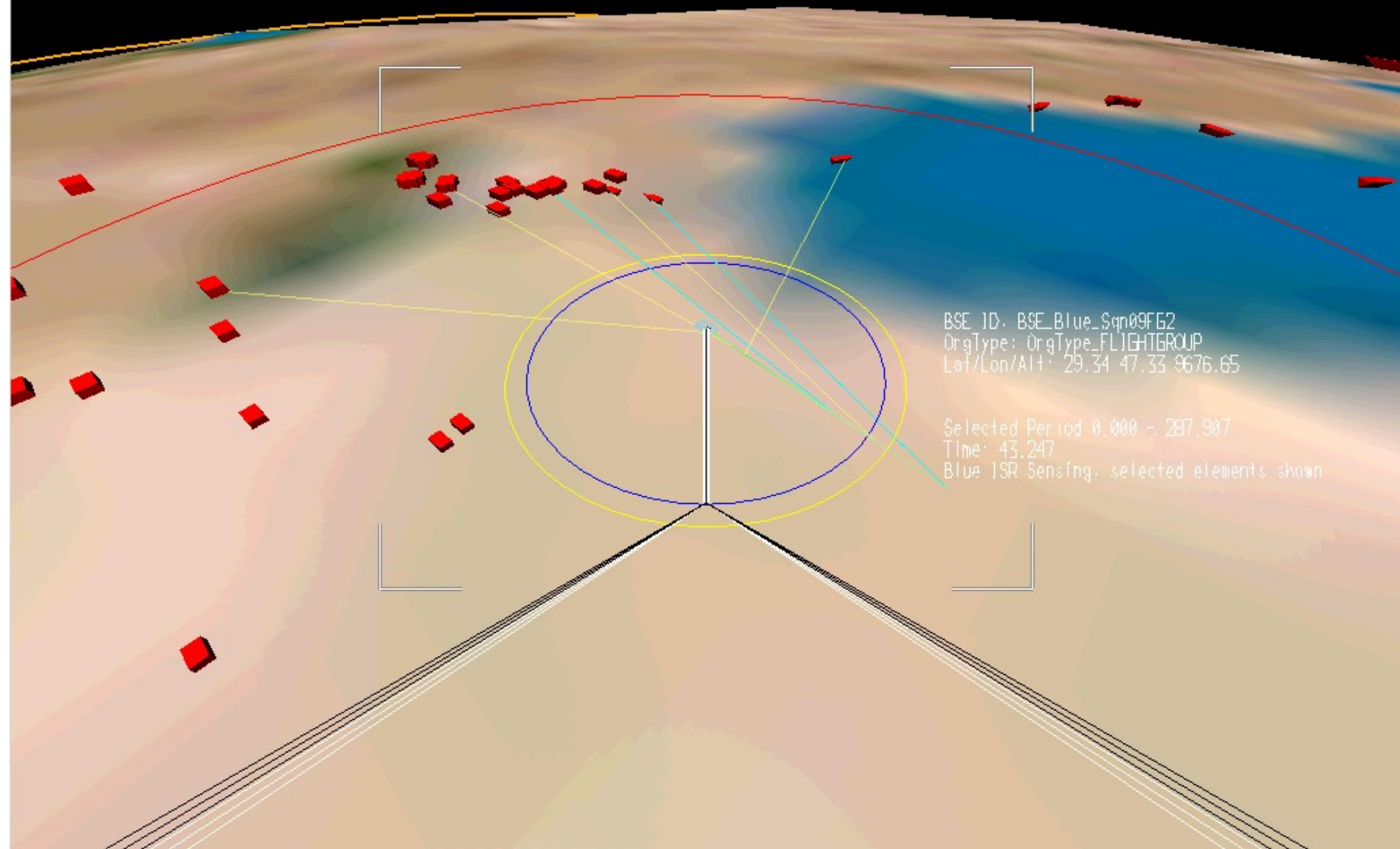
# Direct Fire Engager



# Direct Fire Engagement

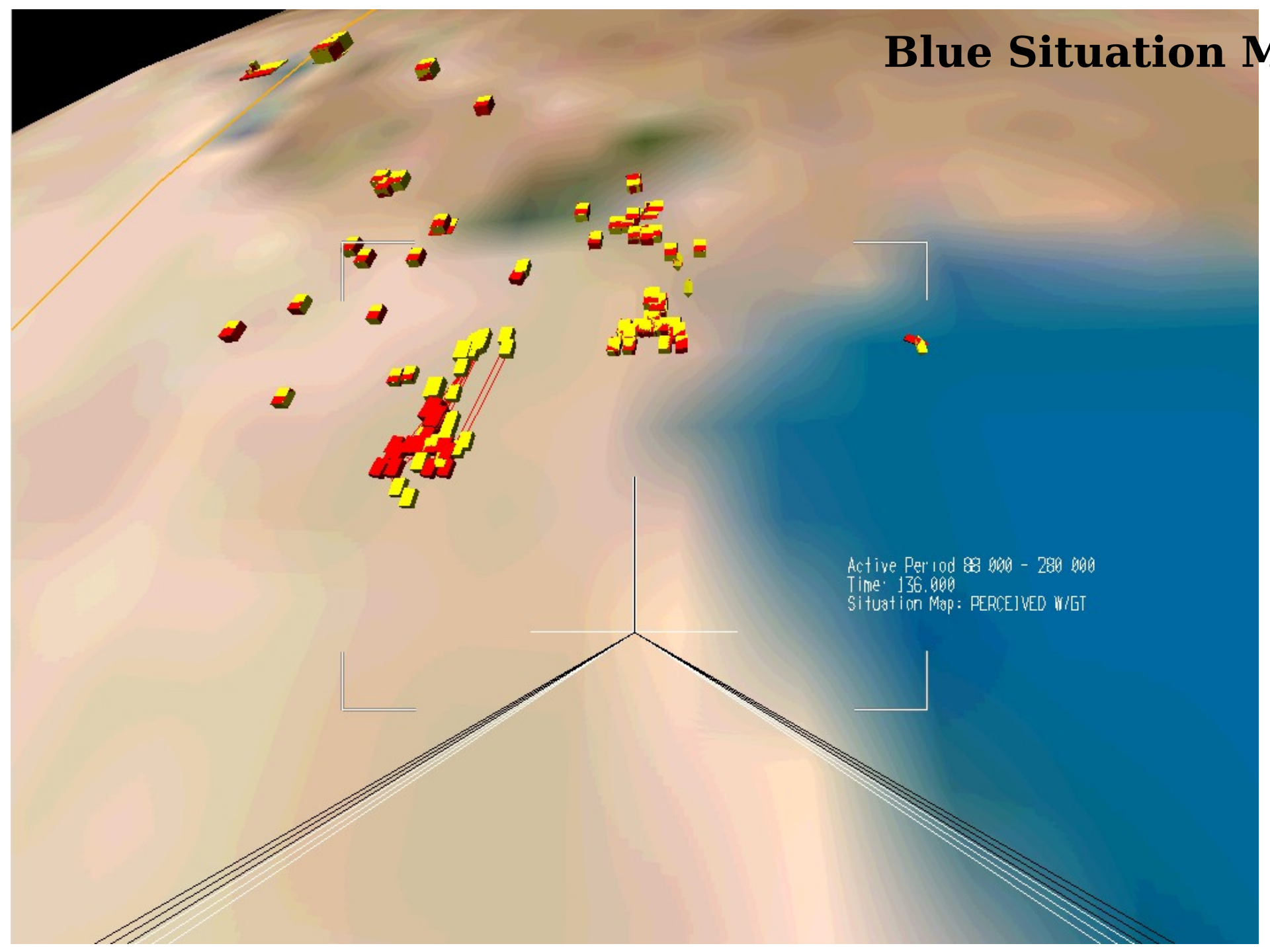


# Blue ISR Sensor Movement and



# Blue Situation M

Active Period 88 000 - 280 000  
Time: 136.000  
Situation Map: PERCEIVED W/GT







# Topics

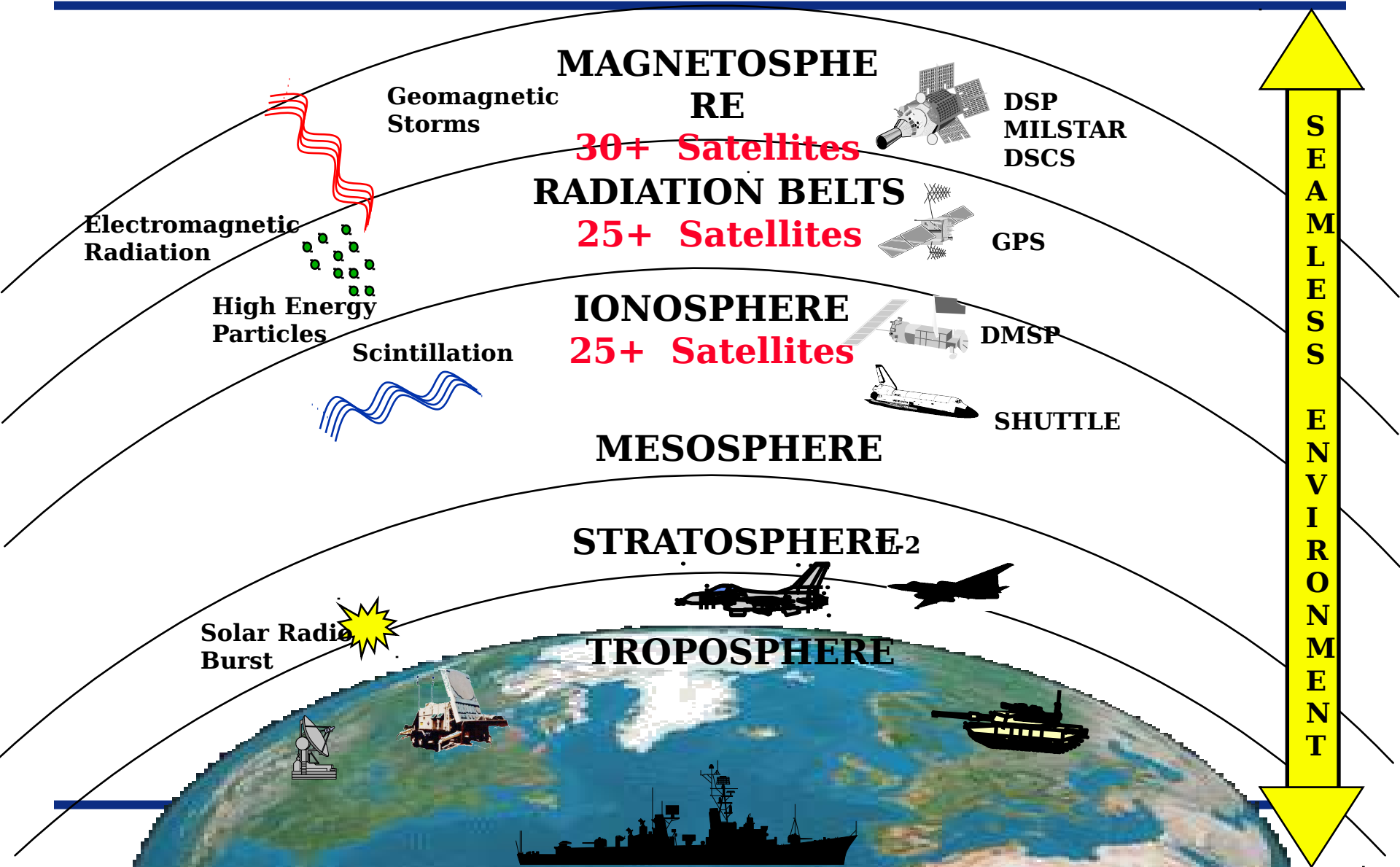
- **JWARS Status**
- **Space Functionality Summary**
- **Collection Plan**
- **Input Data Population and Manipulation**
- **Output Analysis Tools**
  - ❖ **HCI Quick Plots**
  - ❖ **Grapher2000**
  - ❖ **Multi-dimensional Visualization**
- **Open Issues**
  - ❖ **Space Weather**
  - ❖ **STORM's CMMS for Space**





U.S. AIR FORCE

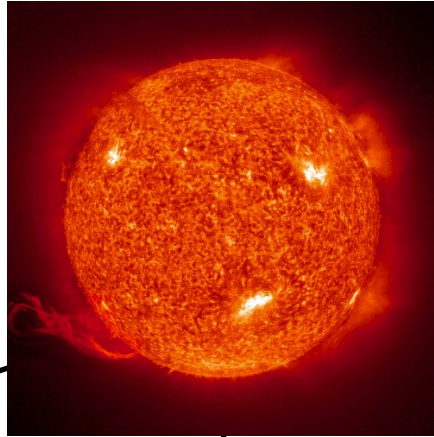
# Operational Context





U.S. AIR FORCE

# Space Weather Impacts



## Electromagnetic Radiation

**ARRIVAL: 8 min**  
**DURATION: 1-2 HOURS**

### EFFECTS

- HF RADIO BLACKOUT
- SATCOM INTERFERENCE
- RADAR INTERFERENCE
- SATELLITE ORBIT DECAY

## High Energy Charged Particles

**ARRIVAL: 15 MIN TO FEW HOURS**  
**DURATION: DAYS**

### EFFECTS

- SATELLITE DISORIENTATION
- SPACECRAFT DAMAGE
- FALSE SENSOR READINGS
- LAUNCH PAYLOAD FAILURE

## Electrically Charged Particle Clouds

**ARRIVAL: 2-3 DAYS**

### EFFECTS

- GEOLOCATION ERRORS
- SATCOM DISRUPTIONS
- SPACECRAFT ANOMALIES
- SATELLITE ORBIT DECAY
- RADAR FALSE TARGETS

• GEOLOCATION ERRORS

ASTRONAUT HEALTH

*Integrity Service Excellence*



# STORM's CMMS for Space

- Developed by Innovative Management Concepts
- AFSPACE provided input
- Categorized by
  - ❖ Competency
  - ❖ General Capabilities
  - ❖ Operational Objectives
  - ❖ General Tasks
  - ❖ Space functional area
- Needs to be review/evaluation by Space Community
- Possible use by JSSPAR



# Summary

- Good initial start on effects of Space on Warfighter
  - ❖ Constrained by ORD
  - ❖ Space ORD being developed by USSPACECOM/AN at request of Dep J3
- Additional Space functionality planned for post Release 1 versions
- Encourage input on appropriate functionality to be included in JWARS